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<p>(54) Title: SECONDARY AIR ADDITION TO ENHANCE COMBUSTION IN SEMI-ENCLOSED HEATING APPARATUS</p> <p><b>(57) Abstract</b></p> <p>A heating apparatus and its method of use; the apparatus including a burner means which facilitates the mixing and ignition of a primary fuel air mixture with additional exposure of the resultant flame to fresh secondary air downstream of ignition of the fuel/primary air mixture, to enhance the completeness of combustion of the fuel in a low oxygen environment. The secondary air can be introduced to substantially encapsulate or sheath at least a part of the flames. The method and apparatus includes providing a fuel/primary air mixture which creates a preferred orange/yellow flame and enables enhanced combustion of that mixture on exposure to the secondary air.</p>			

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SECONDARY AIR ADDITION TO ENHANCE COMBUSTION IN SEMI-ENCLOSED HEATING APPARATUS

This invention relates to heating apparatus and more particularly to a fuel burner assembly for use in a semi-enclosed heating apparatus. For the purposes of 5 this specification, a semi-enclosed heating apparatus is regarded as a heating apparatus in which at least the ingress of air to support combustion and/or egress of the product of combustion are controlled.

10 In the past heating apparatus utilising a semi- enclosed firebox and a fuel burner arrangement have often encountered difficulties in being able to operate at sufficiently high levels of burning efficiency to avoid excess products of combustion through incomplete 15 burning yet provide high heat output with low levels of flue heat wastage. There is a tendency in semi-enclosed combustion apparatus for incomplete combustion. This is generally as a result of an oxygen deficiency caused by conflicting effects of minimal air ingress or passage 20 through the semi-enclosed firebox for efficiency, and the need for sufficient oxygen or inlet air for combustion.

Attempts have been made in the past in semi- 25 enclosed oil burners to achieve high efficiency by providing an air inlet directed toward a flame front and

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adjusting the air/fuel ratio so as to achieve maximum efficiency. This is known as "blue flame" technology; such combustion is characterised by the emission of a blue flame.

5

Blue flame burners are generally used for water or space heating purposes, however in areas where the flame is required to be visible for aesthetic purposes, such as in domestic or commercial fireplaces where not only 10 heating but also the appearance of a traditional fire burning is required, clearly blue flame technology is not acceptable.

It is an object of this invention to come some way 15 in overcoming the abovementioned problems or at least provide the public with a useful choice.

Other objects of this invention will become apparent from the following description.

20

According to one further aspect of this invention there is provided a method of burning fuel in a semi-enclosed chamber including the steps of introducing and igniting a fuel and primary air via a burner means 25 mounted in said chamber, exposing a resultant flame to at least one secondary air stream adjacent said burner

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downstream of ignition of said fuel/primary air mixture to enhance the combustion of said fuel.

According to a further aspect of this invention  
5 there is provided a method of burning fuel in a semi-  
enclosed chamber including the step of burning fuel in a  
fuel/primary air mixture which creates a substantially  
yellow/orange flame.

10 According to a further aspect of this invention  
there is provided a burner apparatus including a primary  
burning means for in use introducing combustible fuel  
and air to said burner, secondary air means provided to  
in use introduce and direct a stream air adjacent to a  
15 flame emanating from said burner to position a portion  
of said secondary air alongside at least some of said  
flames at least downstream of ignition of said fuel.

According to a further aspect of this invention  
20 there is provided a burner mounted within a semi-  
enclosed chamber capable of creating in use a low oxygen  
environment, the secondary air inlet means provided to  
in use introduce secondary air to said flames from an  
exterior of said chamber to enhance combustion of said  
25 fuel in said chamber.

- 4 -

According to a further aspect of this invention the burner apparatus provides the secondary air inlet means to form a stream of air which substantially flanks at least a portion of the flame downstream of ignition.

5

According to a further aspect of this invention there is provided a burner apparatus incorporating control means for controlling a mix of said fuel/primary air.

10

According to a further aspect of the invention the burner apparatus provides influencing means to influence the orientation of the stream of secondary air in a predetermined manner to influence a burn path of adjacent flames on combustion of said fuel/air mixture.

15  
According to a further aspect of this invention the secondary air inlet in use provides a stream of secondary air which substantially surrounds or encircles at least a portion of the flames downstream of ignition.

20  
Other aspects of this invention should be considered in all its novel aspects and will become apparent from the following description. Modifications 25 are envisaged and may be incorporated without departing from the scope or spirit of the invention.

- 5 -

The preferred form of the invention will now be described with reference to a gas fired semi-enclosed heater. Whilst the invention is described with reference to such a device and one which incorporates "visual flame" characteristics preferably in association with ceramic fire logs and the like, the invention is not limited thereto and it is to be appreciated that the invention has widespread application across a variety of burner/heater arrangements.

10

The burner apparatus is preferably housed within a semi-enclosed housing chamber or firebox formed in suitable durable materials, such as mild steel and the like.

15

Preferably the burner apparatus is provided for use in the burning of gas such as natural gas or propane in conjunction with primary air in a substantially known manner, that is, where a jet of gas is introduced into a 20 burner feed tube and where it mixes with predetermined amounts of primary air to be passed to a burner, for example an elongate grille incorporating a burner gauze perhaps covered with vermiculite, perlite or other non-combustible material and having ceramic fire logs 25 situated thereabove.

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In such arrangements it will be appreciated that ignited gas will burn with the primary air to provide visual flame characteristics, that is, the appearance of a traditional log fire within an enclosed fire chamber.

5

The burning of the gas and primary air is preferably arranged to provide a yellow or orange flame. In the preferred form this is achieved by controlling the mix ratio of the gas and primary air so that the required characteristics are provided. It is known that such yellow/orange flame characteristics generally do not provide for efficient combustion and there is a tendency for sooting, unburnt emissions to exit from the fire chamber and general inefficiency.

10  
15

The present invention provides for the introduction of secondary air downstream from ignition of the fuel/primary air mix. Secondary inlet air is introduced in a "sheet like" stream substantially adjacent at least two sides of the burner to provide a "sheathing" or partial "encapsulation" of the flame downstream from ignition.

20  
25  
Should there be insufficient oxygen in the fuel/primary air mix and in the area of the chamber surrounding the burner for the fuel to completely burn, further oxygen is drawn from the secondary air stream to

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ensure that the most complete combustion possible is achieved, notwithstanding that in other areas of the chamber, there may be a general oxygen deficiency.

5        Thus, the invention enables the required desirable visual flame characteristics with a minimal flow of air and combustion gases through the chamber to thus reduce unwanted heat losses from the flue of the apparatus, yet achieve relatively high levels of combustion heat and  
10      low exhaust emissions.

The preferred form of invention also facilitates control of the "flow" of the flame by introduction of the secondary air in such a way that, for example, the  
15      flame can be "parted" to pass either side of a fire log or other obstruction to avoid undue sooting and/or other incomplete combustion of fuel which would normally occur should the flame play upon the log in an uncontrolled manner. Directional influence on the flames is achieved  
20      by providing directed ports, apertures or vanes in the secondary air outlet which create a jet or jets of secondary air in a predetermined direction. This enables influence of flame orientation in use.

25      The preferred embodiment of the invention will now be described with reference to the accompanying drawings in which:

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5           Figure 1 is a substantially diagrammatic cross-sectional side elevation of a heater apparatus incorporating the burner according to the invention mounted in a semi-enclosed firebox in conjunction with a vermiculite topped burner as burner described hereinbefore, mounted with fire logs thereabove.

10           Figure 2 shows a cut away cross-sectional view of the burner means per se of Figure 1.

15           With reference to the drawings, in particular Figure 1, the heater apparatus as generally indicated by arrow 1, has walls 2 to define a chamber 3 therein in which a burner 4 and associated fire logs 5 are housed. (See also Figure 2).

20           A front wall 6 of the heater 1 preferably incorporates a window or viewport 7 which enables, in use, the heater apparatus to provide "visual flame" characteristics.

25           The burner 4 in the preferred form of the invention is arranged to be substantially elongate and extend approximately across the width of the heater chamber 3, a length substantially commensurate with a

- 9 -

length or the fire logs 5 to crease the effect of the base of a traditional fire.

In the preferred form of the invention, the burner 5 4 is preferably formed in suitable fire resistant materials, such as metals, and is arranged to be generally triangular in cross-section as is seen by Figures 1 and 2. Preferably the burner 4 provides a substantially inclined gas permeable upper front face 8 upon which is mounted the bed of vermiculite 9 or other non-combustible particulate material supported by a gauze sheet 7.

Beneath the upper front face 8 and in a 15 substantially plenum chamber 11 is preferably arranged a elongate diffuser 12 which is perforated at predetermined intervals and coupled with a gas supply pipeline 13 (see Figure 1) so that it will be appreciated a controlled amount of gas can be discharged 20 into the plenum chamber 11 and mix with primary inlet air from an air inlet passageway 14 in a base of said heater casing 2 via preferably a perforated bottom portion 15 of said burner casing 4. An additional elongate gas jet 16 is provided along an upper rear 25 portion of the burner 4 which does not have the vermiculite bed 9 mounted thereon.

- 10 -

In an alternative embodiment of the invention, the elongated diffuser is dispensed with and is alternated by one or a plurality of gas jets with an associated ventury primary air aperture such that a flow of gas through said gas outlet creates a ventury effect to draw primary air into the plenum chamber 11.

It will be appreciated that in use, the burner 4 facilitates the supply of a fuel/primary air mixture through the vermiculite bed 9 and from the additional jet 16 which when ignited will burn and provide the basis of a flame front beneath and about the fire logs 5. The vermiculite bed 9 will glow under the effects of the heat of combustion, and the flames extending from the gas jet 16 will tend to lick about the fire logs to represent traditional burning of logs on a fire.

In the preferred form of the invention the gas jet 16 provides a "sheet" of flame which is preferably arranged to pass between a front fire log 5a and a rear fire log 5b so as to enhance the impression of traditional burning through the viewport 7 in use. Preferably an upper pair of fire logs 5c can be arranged substantially transversely of the fire logs 5a and 5b so that as the sheet of flame passes through the fire logs there is the impression of a stack of logs 5 burning within the fire chamber 3.

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A control means (not shown) provided on the gas supply line 13 is used to ensure that a mix ratio of primary air and fuel in the burner 4 can be achieved so that flames emanating from the burner 4 are substantially yellow/orange. Relatively incomplete burning can thus result.

Secondary air inlets 20, 21 and 22 are in the preferred form of the invention provided to in use pass secondary inlet air in a substantially controlled manner (such as by combustion draft) to the flame front of ignited fuel/primary air. The secondary air is preferably introduced to the burning fuel/primary air on either side of said burner 4, that is, up the inclined upper front face 8 and from behind the burner 4, in a stream as shown particularly in figure 1 so that the secondary air is introduced to the flame front of fuel/primary air in a stream to substantially "encapsulate" or "sheath" portions of the flame and enhance the burn yet enabling the flame to retain its yellow/orange flame colour.

Preferably the secondary air inlets 20, 21 and 22 are provided to be controllable by adjustable choke means 23 (see Figure 1) connected with an actuator 24 which enables control and/or adjustment or setting of a mix ratio of fuel/primary air to secondary air and the "split" of secondary air passing through the respective

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secondary air inlets 20, 21 and 22. It is envisaged that setting of the choke means 23 can be operator adjustable within a predetermined range, or alternatively factory set.

5

An alternative embodiment of the invention, the secondary air inlets 20, 21 and 22 can be provided as a series of slots, tubes or apertures preferably adjacent to the point of ignition of the fuel/primary air mix.

10

It will be understood that the secondary air inlet 22 is optionally provided and is arranged as a passageway behind the combustion area of the chamber 3 so that secondary air passing therethrough is preheated and exited in an upper region of the chamber 3 to further enhance the combustion of the fuel and influence the flow of combustion gases forwardly in the chamber 3, preferably beneath a baffle portion 2a, to exit a flue 17 of the fire box 2. The construction and arrangement of the secondary air inlet 22 is in no way essential to the preferred embodiment of the invention and in many instances is not required.

Whilst the baffle arrangement 2a is shown in the preferred form of the invention to extend forwardly of a rear wall of the casing 2 to define an extended pathway 18 for combustion gases, this assembly is not essential

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to the invention and in some alternative embodiments is dispensed with.

The secondary air inlets 20, 21 and 22 are  
5 arranged in predetermined orientations relative to the flames fuel/primary air combustion so that the secondary air tends to "direct" or orientate the flames in a predetermined manner. This effect is particularly apparent in respect of the secondary air inlet 20 where  
10 secondary inlet air tends to cause the flames to burn rearwardly of the apparatus substantially beneath the fire log 5a, to create a traditional burning effect, whilst also providing oxygenated secondary air for more efficient combustion. As is seen by figure 2, vanes 19  
15 are also introduced into the secondary air inlet 21 to direct a secondary air flow therefrom, such, for example, to slit the flame about the upper fire log 5c to create the impression of flames licking about the fire log 5c but without the flames actually contacting  
20 the fire log 5c and creating sooting, incomplete combustion and therefore unwanted emissions from the unit.

It will thus be appreciated that by this invention  
25 there is provided a means of controlling the combustion of fuel/primary air to provide a desired yellow/orange flame whilst enhancing the burning characteristics of

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said flame to achieve higher levels of combustion and thus lower emissions in an enclosed fire chamber with the benefits of low mass throughput through the unit and resultant flue heat losses enabling greater heat output  
5 for a given size of heater apparatus or alternatively an ability to reduce the size and cost of the apparatus whilst retaining heat output.

Whilst the invention has been described to the  
10 reference to a preferred embodiment and reference has been made to alternative embodiments. The invention is not limited to the prevalent embodiment and modifications and developments are envisaged and can be incorporated without departing from the invention as  
15 defined in the appended claims.

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CLAIMS

1. A Method of burning fuel in a semi-enclosed chamber including the steps of introducing and igniting a fuel and primary air mix via a burner means mounted in said chamber, introducing at least one secondary air stream immediately adjacent flames, downstream of a point of ignition of said fuel/primary air mixture to enhance the combustion of said fuel.  
5
2. A method as claimed in claim 1 including the step of burning said fuel in a fuel/primary air mixture which creates a substantially yellow/orange flame.  
10
3. A method as claimed in Claim 1 or Claim 2 including the step of creating a low oxygen environment within which said fuel/primary air mixture is ignited, and to exposing said resultant flame to the at least one secondary air stream to enhance the combustion of said fuel.  
15
4. A method as claimed in any one of the preceding Claims including the step of introducing said secondary air about said flames to substantially enclose said flames within a sheath of secondary air.  
20
- 25

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5. A burner apparatus including a primary burning means for in use introducing a combustible fuel and a primary air mixture for ignition, at least one secondary air supply means provided to in use supply secondary air immediately adjacent flames of said ignited fuel/primary air mixture expose the flames to said secondary air downstream of ignition of said fuel.
10. 6. A burner apparatus as claimed in Claim 5 when mounted in a semi-enclosed fire chamber capable of creating in use a low oxygen environment, the secondary air supply means provided to in use introduce secondary air to immediately adjacent said flame from an exterior of said chamber to enhance combustion of said fuel in said chamber.
15. 7. A burner apparatus as claimed in Claim 6 or Claim 7 wherein said secondary air supply means is arranged to form a stream of secondary air which substantially surrounds or encircles at least a portion of the flame resulting from ignition of said fuel/primary air mixture.
20. 8. A burner means as claimed in any one of the preceding Claims 5 to 7 wherein the secondary air supply means are orientated to direct a flow of secondary air toward said flame to influence a burn path of said flames.

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9. A method as hereinbefore described with reference to the accompanying drawings.

10. A burner apparatus as hereinbefore described with  
5 reference to the accompanying drawings.

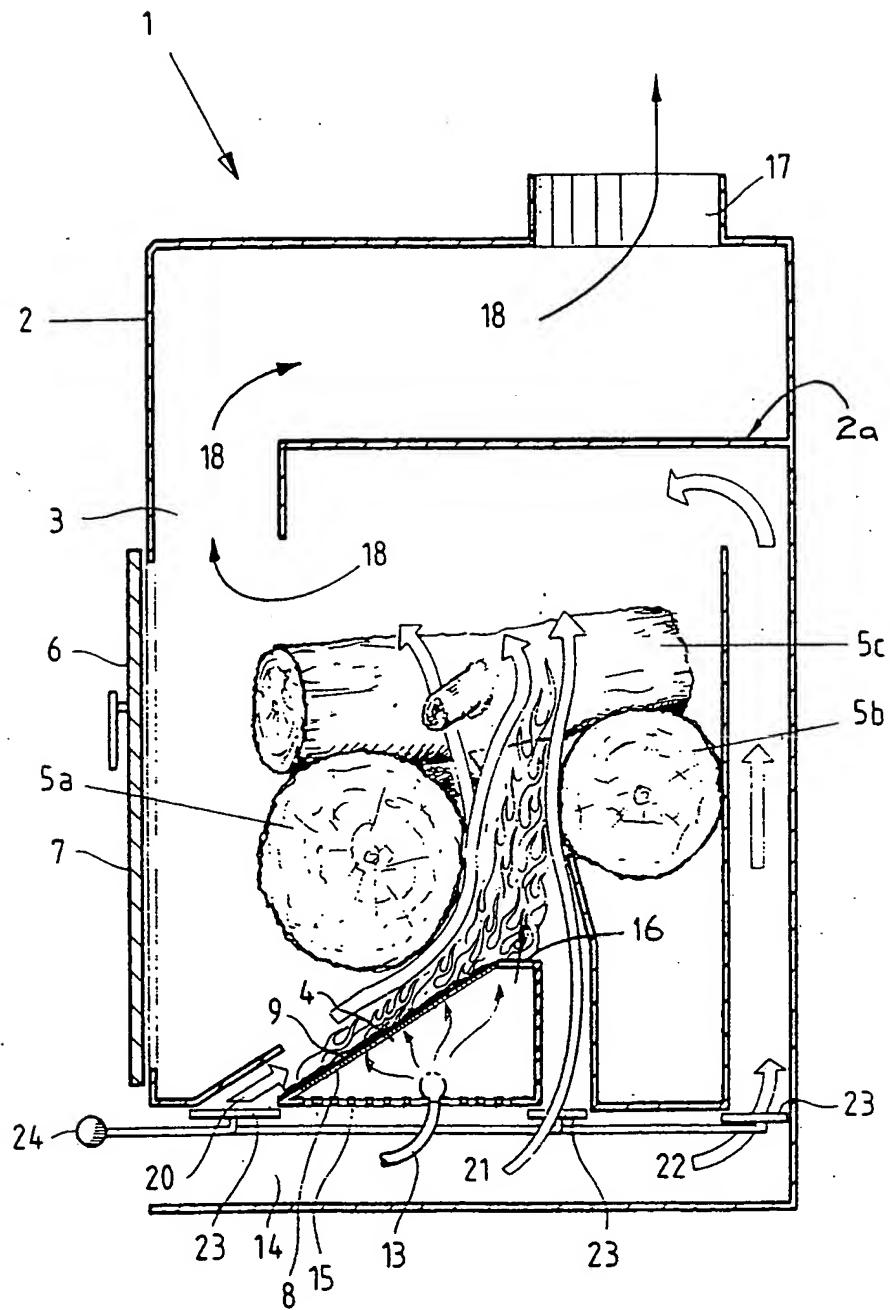
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FIG.1.

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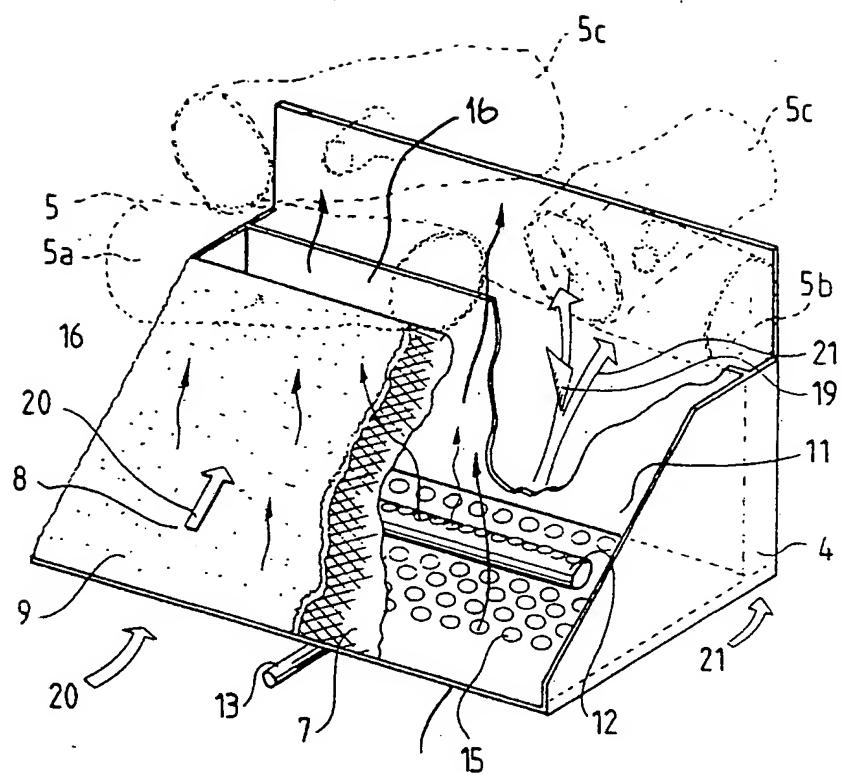


FIG.2.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/NZ93/00020**A. CLASSIFICATION OF SUBJECT MATTER**  
Int. Cl.<sup>5</sup> F23D 14/02, 14/84, F23L 9/02 // F24C 3/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**Minimum documentation searched (classification system followed by classification symbols)  
IPC Int Cl<sup>3</sup> F23D 13/00, 13/34  
Int Cl<sup>5</sup> F23L 9/02, F23D 14/02, 14/84Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
US : 126/512  
AU : IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	Patents Abstracts of Japan, M-1255, page 48, JP,A, 4-45307 (MATSUSHITA ELECTRIC IND CO LTD) 14 February 1992 (14.02.92) abstract, figure	1,3-8
X	Patents Abstracts of Japan, M-682, page 131, JP,A, 62-238909 (MATSUSHITA ELECTRIC IND CO LTD) 19 October 1987 (19.10.87) abstract, figure	1,6,7
X	Patents Abstracts of Japan, M-682, page 131, JP,A, 62-238910 (MATSUSHITA ELECTRIC IND CO LTD) 19 October 1987 (19.10.87) abstract, figure	1,3-8

 Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search 7 July 1993 (07.07.93)	Date of mailing of the international search report 12 July 1993 (12.07.93)
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International application No.

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
X	Patents Abstracts of Japan, M-685, page 19, JP,A, 62-245013 (MATSUSHITA ELECTRIC IND CO LTD) 26 October 1987 (26.10.87) abstract, figure	1,3-5,7-8
X	DE,A, 3916142 (VAILLAND J GMBH & CO) 27 June 1988 (27.06.88) See col 3,4, claims and figures	1-2,4-5,7-8
X	US 4976253 (BEAL et al) 11 December 1990 (11.12.90) See col 2, claims and figures	1,2,4-8
A	US 4502463 (GREGORY) 5 March 1985 (05.03.85) See col 2,3, claims and figures	2

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/NZ93/00020**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
DE 3916142	AT 1650/88
JP 4-45307	
JP 62-238909	
JP 62-238910	
JP 62-245013	
US 4976253	CA 2016972
US 4502463	
	<b>END OF ANNEX</b>